Expertise development for a visual task: Eye movements, verbal reports, and spatial abilities in air traffic control

knowledge & development centre
Mainport Schiphol

Expertise development in a visual task

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Errors in Air Traffic Control (ATC) are a risk to human life hence, air traffic controllers have to make fast and correct decisions. These decisions are based on complex visualizations of a surrounding area (*figure 1*). These visualisations are complex because they involve representations of many moving airplanes including their labels with crucial information (i.e., call sign, speeds, heading, etc.). Despite of increasing air traffic, live of people must not be at risk, so further understanding the causes for successful air traffic controllers as well as understanding the difficulties of less experienced air traffic controllers is crucial. Such findings may inform user interface designers and instructional designers in ATC. Hence, this study examined how experts, intermediates, and novices in ATC perceive and interpret ATC stimuli on a perceptual level (by means of eye-tracking) and on a performance level. Furthermore, the potentially mediating influence of spatial abilities was investigated. ATC decisions and a potential mediating influence of spatial abilities was investigated.

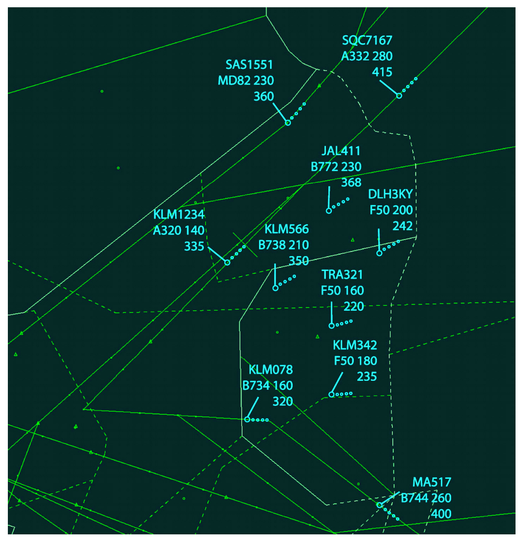


figure 1

Method

Knowledge Level

Experts (n=10)
Intermediates (n=9)
Novices (n=12)

X

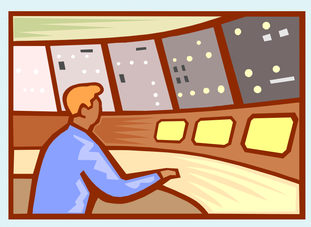
Spatial Ability Tests

Logical Order (Stebner et al, 2009)
Paper Folding (Stebner et al, 2009)
Mental Rotation (Vandenberg et al, 1978)

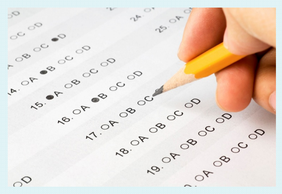
X

Task Difficulty

3 x Easy
3 x Medium
3 x Difficult

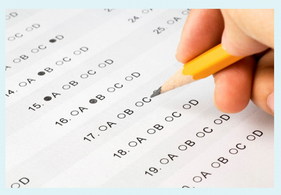


Performance and Perceptiual Processes (eye-tracking)



Mental Effort Questionaire (Paas, 1992)

X 9



Spatial Ability (Questionaires)

Participants

31 individuals
(*M* = 26.45 years, *SD* = 6.31; 8 females and 23 males):

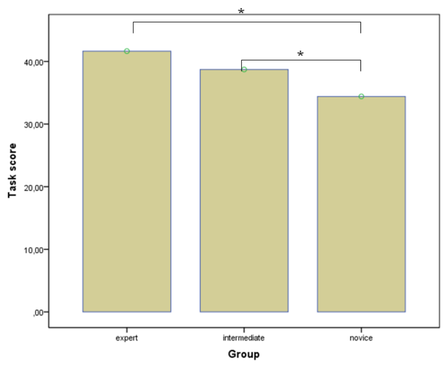
10 experts
(full licensed air traffic controllers);

9 intermediates
(trainees in the final phase of their on the job training);

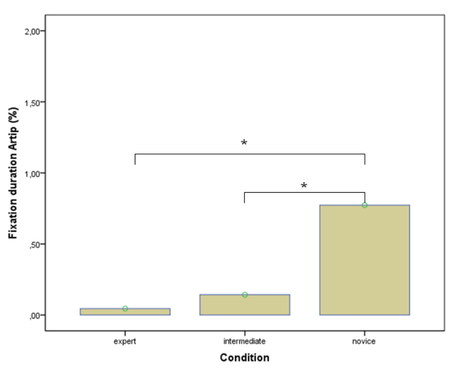
12 novices
(trainees in the initial phase of the ATC training)

Results

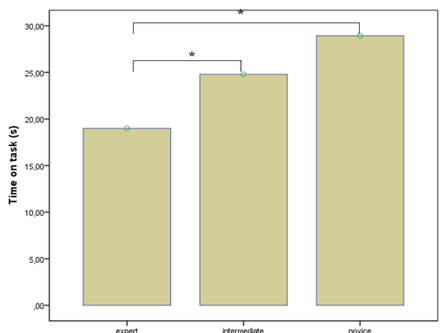
Performance



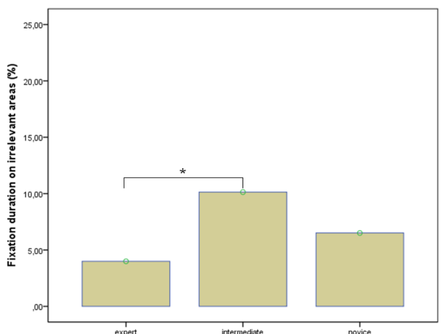
Fixation Duration Artip



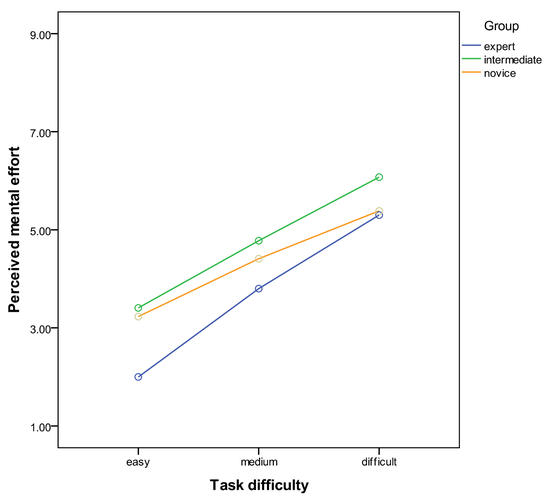
Time on Task



Fixation Duration Content



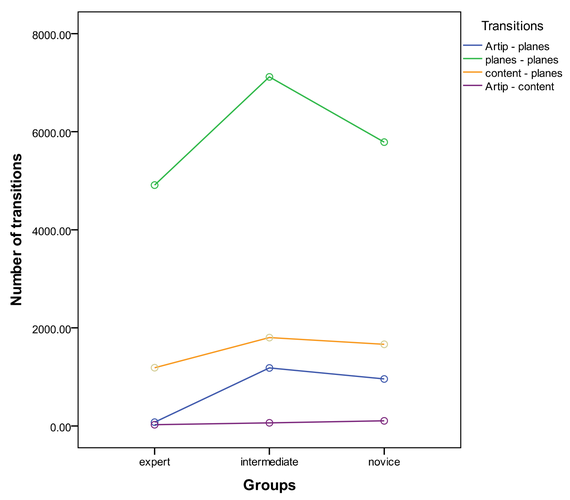
Mental Effort



Main effect on expertise level

And main effect on task difficulty

Transitions



Main effect on expertise level

And main effect on transition type

Conclusions

Experts…
- and intermediates perform better than novices.
- are faster than intermediates and novices.
- perceive less mental effort than intermediates.
- need fewer transitions between AOIs than intermediates and marginally fewer than novices.

Novices…
- need to look more on Artip (and look sooner on Artip) than intermediates and experts.

Intermediates…
- look more on content than experts.

But: No expertise difference were found in spatial ability.

References

Stebner, F., Lebens, M., Wirth, J., & Opfermann, M., (March, 2009). Learning from animations and static pictures: The impact of spatial ability and cognitive load. Paper presented at 3th International Cognitive Load Conference, Heerlen, The Netherlands.

Paas, F. (1992). Training strategies for attaining transfer of problem-solving skill in statistics: A cognitive-load approach. *Journal of Educational Psychology, 84*, 429-434.

Vandenberg, S. G. & Kuse, A. R. (1978). Mental rotations, a group test of three dimensional spatial visualization. *Perceptual Motor Skills, 47,* 599-604.

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